SEISMIC EVALUATION OF CONCRETE DAMS

USAE CW R&D Program Workshop
Seismic Rehabilitation of Hydraulic Infrastructure

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Goal

- Identify tools, methods, guidance, criteria, and procedures for concrete dams under seismic hazard, to evaluate existing conditions, and to design and implement remediation.

Databases
Rating factors [H,M,L:7,5,0]

- CASE HISTORIES
  - Past performance
  - Original design analyses, and assumptions used
  - Subsequent evaluations
  - Remediations
  - Modifications
  - Lessons learned
  - Geotechnical hazards

Project Statistics

- Response characteristics
  - First few frequencies with reservoir assumptions stated
- Dimensions
- Material properties including foundation
- Measured performance
  - Instrumentation
  - Field testing
  - Actual earthquake loading
- Reservoir design pools
- Actual historical maximum/minimum
- Ground motion
- Sedimentation/Scour

Condition Evaluation
Static and Dynamic
Rating factors [H,M,L: 11,1,0]

- Fc, Ft, Fs,lift lines and foundation contact
- E
- Poisson ratio
- Rock Mass Rating/Classification
- Determination of % of intact joints
- Determination of distribution of concrete properties

Condition Evaluation
Static and Dynamic (cont'd)

- Core/Lab testing /In-situ nondestructive
- Aggregate-alkali reaction
- Sediment/Properties alpha, unit weight
- Geometry is needed
- System discontinuities
  - Dam cracks
  - Dam joints
  - Foundation
- Condition of drains
- Field tests to determine prototype response

Electrical/Mechanical Equipment
Rating factors [H,M,L: 0,10,2]

- Evaluation of gates/valves/bulkheads, etc.
  - Guidance
  - Methods
  - Dynamic testing
- Performance criteria
- Details of elements crossing joints
- Cranes

Analytical Tools
Rating factors [H,M,L: 7,5,0]

- Economical development of user-friendly and adequate tools
- Pre/post-processors to apply to in-house, and proprietary and academic software
- Risk analysis and probabilistic models
- Seismic uplift tools experimentally verified
- Two-dimensional finite element model to do static and dynamic linear elastic analysis with capability to represent modification options (post-tenstioning, stage construction, etc.)

Analytical Tools
Rating factors [H,M,L: 7,5,0] (cont'd)

- Analytical tools that include geometric discontinuities (I.e., lift lines, contraction joints, existing cracks, etc.)
- Acceleration response at any given nodal point of the dam to be used as excitation on other structural elements

Guidance
Rating factors [H,M,L: 4,8,1]

- Performance criteria
- Design criteria
- Instrumentation programs
  - Types of instruments
  - Monitoring plans
  - Evaluation of data
- Clarification of definition and determination of ground motion (Continuum from OBE to MCE, and selection of MDE)

Guidance
Rating factors [H,M,L: 4,8,1] (cont'd)

- Probabilistic load combinations
- Analysis of consequences of structural failure
- Sliding stability including slip displacements in dam foundations systems
- Overturning stability including rotational displacements
- Significance of the vertical component in stability calculations
- Inspection manual

Organizational Requirements
Rating factors [H,M,L: 4,8,0]

- Training
  - Ground motion: definitions, selection, and applications
  - Analytical tools
  - Guidance
  - Inspection
- Demonstration projects to leverage work on individual on-going projects

Organizational Requirements
Rating factors [H,M,L: 4,8,0]

- Means for resource sharing among Districts to address specific and common issues
- A search engine to allow input of keywords to identify pertinent guidances
- COE developed vs. commercially available software (com624 vs. LPILE)
- Funding maintenance cost of COE and proprietary software

Others
Rating factors [H,M,L: 0,7,3]

- Evaluation of powerhouses
- Interaction between adjacent embankment-concrete structure
- Seismic response of post-tensioning
- Spatial variation of ground motions
- Spillway bridges and piers
- RCC
  - Seismic properties
  - Seismic behavior